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PATENT SPECIFICATION

.DRAWINGS ATTACHED

1,150,125

1,150,125

Date of filing Complete Specification: 21 February, 1968.

Application Date: 21 February, 1967. No. 8098/67

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Index at Acceptance:—H4 L (11C, 19, 26F6, 26G1B); G1 N (1A1, 1A2P, 1A3A, 1A3B, 1C, 1D2, 1F, 3S7C, 4A, 4D).

Int. Cl.:—H 04 b 7/00.

COMPLETE SPECIFICATION

Oral Muscular Controlled Electronic Actuating Means

ERRATUM

SPECIFICATION NO. 1,150,125

Page 1, line 50, *for* "positioned" *read* "positioning"

THE PATENT OFFICE

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apparatus without having to use his hands or feet.

In accordance with the present invention equipment for enabling an operator to control remotely-positioned apparatus, comprises a pressure-sensitive sealed device adapted to be held in the mouth at a position where pressure generated by relative movement between the operator's mandible and maxilla can be brought to bear on the device, an arrangement for detachably mounting the device on the operator's teeth, a transducer providing an electrical signal output significant of the pressure applied to the device, a radio transmitter connected to be operatively controlled by the transducer output signal and adapted to radiate a transmission indicative of the pressure, and an electrical power source supplying the transducer and transmitter and mounted therewith inside the device. Throughout this specification the expression "transducer" is to be understood as meaning any device constructed to provide an electrical signal significant of the pressure applied to the transducer. The pressure may be occlusal pressure or, if preferred, lateral pressure or some combination of occlusal and lateral pressure. Examples of transducers which are capable of being used in the invention are strain gauge elements relying on change

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relative positions of the maxilla and mandible. For simplicity, the maxilla and mandible may be considered as being the upper and lower jaws in which the upper and lower teeth are mounted. The periodontal tissues in which the teeth are mounted are highly sensitive to pressure and therefore, by suitably positioning the device so that the pressure applied to it is also transmitted to the teeth, use can be made of the highly sensitive feedback system operating between the mouth and the brain.

The device is suitably in the form of a sealed capsule and it is preferably provided with a clasp arrangement for attaching it to a molar tooth or teeth, preferably on the upper jaw. Although the device may be arranged to be acted upon directly by the teeth of the opposite jaw, preferably a prod attached to one of the teeth of the opposite jaw is used to vary the pressure exerted on the transducer in the device.

A suitable position for mounting the device in the mouth is inside the buccal sulcus of the cheek cavity. The device can be made extremely small by the use of integrated circuit techniques and transistors; and, by mounting it in the buccal sulcus towards the back of the mouth, it does not impede speech or other functions of the mouth.

The device may be designed to respond to

SEE ERRATA SLIP ATTACHED

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Int. Cl.:—H 04 b 7/00.

COMPLETE SPECIFICATION

Oral Muscular Controlled Electronic Actuating Means

I, JOSEPH CHARLES VICTOR MITCHELL, a British Subject, of Midleton Lodge, Easebourne, Lane, Midhurst, Sussex, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the control of remotely-positioned apparatus and, more specifically, is directed towards equipment for enabling an operator to control such apparatus without having to use his hands or feet.

In accordance with the present invention equipment for enabling an operator to control remotely-positioned apparatus, comprises a pressure-sensitive sealed device adapted to be held in the mouth at a position where pressure generated by relative movement between the operator's mandible and maxilla can be brought to bear on the device, an arrangement for detachably mounting the device on the operator's teeth, a transducer providing an electrical signal output significant of the pressure applied to the device, a radio transmitter connected to be operatively controlled by the transducer output signal and adapted to radiate a transmission indicative of the pressure, and an electrical power source supplying the transducer and transmitter and mounted therewith inside the device. Throughout this specification the expression "transducer" is to be understood as meaning any device constructed to provide an electrical signal significant of the pressure applied to the transducer. The pressure may be occlusal pressure or, if preferred, lateral pressure or some combination of occlusal and lateral pressure. Examples of transducers which are capable of being used in the invention are strain gauge elements relying on change in electrical resistance as well as elements such as piezoelectric crystals whose electrical output is influenced by applied pressure.

The invention is based on the realisation that the average person naturally is capable of exerting a fine degree of control over the relative positioned of his maxilla and mandible as well as on the pressure exerted between them. Also the sensory nerves act as a highly sensitive feedback system which enables the brain to know precisely the relative positions of the maxilla and mandible. For simplicity, the maxilla and mandible may be considered as being the upper and lower jaws in which the upper and lower teeth are mounted. The periodontal tissues in which the teeth are mounted are highly sensitive to pressure and therefore, by suitably positioning the device so that the pressure applied to it is also transmitted to the teeth, use can be made of the highly sensitive feedback system operating between the mouth and the brain.

The device is suitably in the form of a sealed capsule and it is preferably provided with a clasp arrangement for attaching it to a molar tooth or teeth, preferably on the upper jaw. Although the device may be arranged to be acted upon directly by the teeth of the opposite jaw, preferably a prod attached to one of the teeth of the opposite jaw is used to vary the pressure exerted on the transducer in the device.

A suitable position for mounting the device in the mouth is inside the buccal sulcus of the cheek cavity. The device can be made extremely small by the use of integrated circuit techniques and transistors; and, by mounting it in the buccal sulcus towards the back of the mouth, it does not impede speech or other functions of the mouth.

The device may be designed to respond to

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thrusts exerted on it in different directions to provide, respectively, different intelligence in the radiated transmission. However, this involves complex circuitry and possibly more than one transducer so that it is generally preferred to use a device arranged in its most compact elementary form so that a number of them can be arranged side by side at positions where pressure can be brought to bear on them selectively by suitable movement of the operator's jaws. Each device can then be arranged to radiate a different signal so that the intelligence provided by the devices can be distinguished.

Preferably the transducer responds to applied pressure by upsetting a balanced bridge circuit. The degree of unbalance can then be detected by a suitable amplifier connected to control an astable pulse generator. A radio transmitter may be controlled by the output of the pulse generator so that when no pressure is applied the pulse generator controls the radio transmitter to provide a space mark ratio of one. This ratio is upset in accordance with the magnitude of the pressure applied to the transducer. A decoder associated with a radio receiver associated with the equipment to be controlled, receives the transmission and controls with the intelligence contained in it the operation of a piece of apparatus.

Preferably the device is provided with an overriding ON/OFF switch readily manipulable by the tongue of the operator, or by some extreme position of mandibular excursion. In this way the operator is able to exercise complete control over the equipment and to switch it off at times when it is not required.

The invention will now be described in more detail, by way of example, with reference to the accompanying drawings, in which :—

Figure 1 is a diagrammatic section through one half of an operator's mouth showing opposing molar teeth of the upper and lower jaws, respectively;

Figure 2 shows electrical circuitry in block diagrammatic form; and,

Figure 3 shows the electronic circuitry in more detail.

Turning to Figure 1 an operator has a mouth cavity 1 and a buccal sulcus 2 contained within a cheek 3. An upper molar tooth 4 and a lower molar tooth 5 are also shown.

Disconnectibly attached to the upper tooth 4 is a clasp 6 which detachably mounts on the tooth a capsule 7 disposed in the upper buccal sulcus 2. For the sake of clarity, the parts shown are not drawn to scale. The capsule 7 has sealed into it a removable battery 8 and its lower face is provided with a transducer 9 sensitive to pressure applied upwardly by a prod 10. The prod 10 is of angular shape and is disconnectibly attached to the molar 5 by means of a clasp band 11. Although the drawing shows a single capsule 7, it will be understood that a number of capsules may be arranged side by side mounted together on a single tooth or on respective teeth so that they may, by appropriate relative movement between the operator's maxilla and mandible, be selectively borne on by the upturned end of the prod 10. The degree of pressure applied by the prod 10 to the capsule 7 is preferably sensed by the periodontal nerves and is transmitted as a feedback signal to the brain of the operator.

The electronic circuitry contained in the capsule 7 is shown in Figure 2. This comprises a micro-circuit pressure transducer 9 constructed in the form of a Wheatstone bridge and of suitably small physical size. As an example of such a transducer is one marketed by Ferranti Limited under the code number ZPT 50AB. This has a pressure range of 0-50 pounds per square inch and gives an output of 0-300 millivolts with 9 volts excitation.

The electrical output signal derived from the transducer 9 when the bridge is unbalanced is fed to a paraphase amplifier 12 constructed as a long-tailed pair. The direct current amplifier is necessary to raise the output of the transducer to a suitable level to control later circuitry. A long-tailed pair amplifier has little if any drift characteristics and it is therefore advantageous in micro-miniature circuitry.

The paraphase outputs from the long-tailed pair are fed to an astable multivibrator circuit 13 which controls with its output the duration of oscillation of an output radio transmitter 14. The transducer 9, amplifier 12, multivibrator 13 and transmitter 14 are all energised by a battery 8 which is of mercury type having a 3 volt open circuit voltage.

Figure 3 shows the electronic circuitry in more detail. The bridge circuit of the transducer is shown at 9′ and the degree of upset of the bridge is detected by the transistorised paraphase amplifier 12′ composed of two N.P.N. transmitters having a common emitter and providing paraphase output signals from across their respective collector loads.

The paraphase output signals are fed to respective bases of the astable oscillator 13′ composed also of two N.P.N. transistors each having their collector capacitively coupled to the base of the other. The output from the multivibrator 13′ is taken by way of a resistor 20 from the collector of one of the two transistors and is applied to the base of an N.P.N. amplifying transistor 21 forming a transmitter oscillator. The

collector of the transmitter 21 contains a tuned circuit 22 which is inductively coupled to a choke 23 connected in the base circuit.

The astable multivibrator 13′ provides a stream of square pulses to the base circuit of the amplifier 21, the gaps between the pulses being equal to the pulse length so that the radiated transmission from the amplifier collector load circuit has a mark-space ratio of one. Any unbalance between the paraphase signals obtained from the long-tailed amplifier 12′ causes one of the transistors of the multivibrator to conduct more than the other so that the mark-space ratio fed through the resistor 20 changes. A corresponding change in the mark-space ratio of the radiated transmission from the oscillator 21 occurs which may be detected by a receiver placed a few feet from the mouth of the operator. It will be immediately appreciated from the circuit of Figure 3 that when the right-hand transistor of the multivibrator 13′ conducts, its collector voltage falls and the base of the transistor 21 is biased back beyond cut off to provide a "space" signal.

The circuit shown in Figure 3 may be constructed as an integrated circuit of very small physical size with the inductively coupled coils external to the integrated circuit.

The above described equipment is but one example of the invention. It will be appreciated that the intelligence transmitted by the capsule 7 may use any of the wide variety of intelligence transmission techniques used today with radio. For example, the transducer may be connected to modulate the frequency or phase of the output transmission or, indeed, to modulate the amplitude of the transmission. The long-tailed pair amplifier is preferably a dual silicon planar transistor such as is marketed by Fairchild under the number BFY81 and the same form of transistor may be used as the astable multivibrator.

WHAT I CLAIM IS:—

1. Equipment for enabling an operator to control remotely-positioned apparatus, comprising a pressure-sensitive sealed device adapted to be held in the mouth at a position where pressure generated by relative movement between the operator's mandible and maxilla can be brought to bear on the device, an arrangement for detachably mounting the device on the operator's teeth, a transducer providing an electrical signal output significant of the pressure applied to the device, a radio transmitter connected to be operatively controlled by the transducer output signal and adapted to radiate a transmission indicative of the pressure, and an electrical power source supplying the transducer and transmitter and mounted therewith inside the device.

2. Equipment as claimed in Claim 1, in which a clasping arrangement is provided for attaching the device to a tooth or teeth of the operator.

3. Equipment as claimed in Claim 1 or Claim 2, including a prod provided with a clasp device for attaching it to a tooth or teeth at a position at which the prod can bear on the transducer attached to the opposing tooth or teeth.

4. Equipment as claimed in any one of the preceding Claims, in which the transducer responds to applied pressure by upsetting a balanced resistive bridge circuit.

5. Equipment as claimed in Claim 4, in which the bridge controls operation of a paraphase amplifier providing two electrical output signals controlling operation of an astable multivibrator controlling with its output the mark-space ratio of oscillation of an output transmitter amplifier.

6. Equipment as claimed in Claim 5, in which the paraphase amplifier and the astable multivibrator each comprise a duel silicon planar transistor.

7. Equipment for enabling an operator to control remotely-positioned apparatus, arranged and adapted to operate substantially as described with reference to the accompanying drawings.

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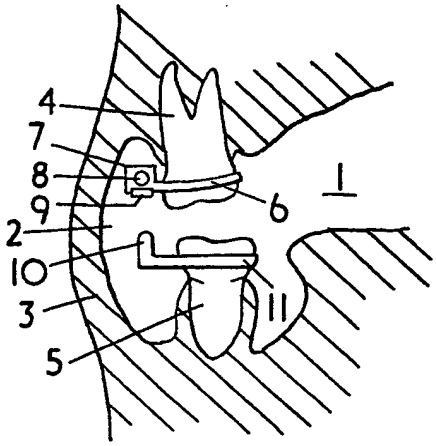

FIG.1.

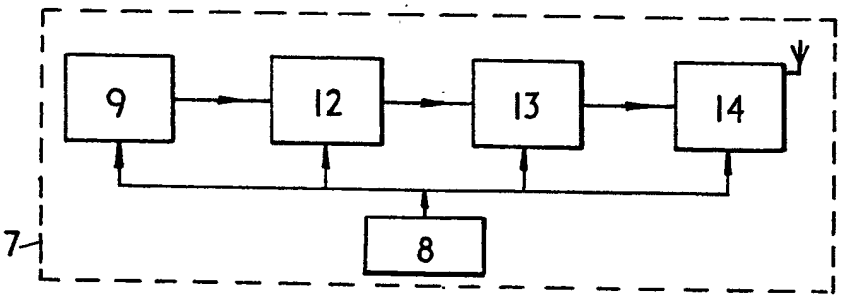

FIG.2.

FIG.3.